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Instruction Manual

No. EB 2163

for

U.H.F. Attenuator

TF 2163

M.I. Technical Publications

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MARCONI INSTRUMENTS LIMITED

ST. ALBANS HERTFORDSHIRE ENGLAND

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Contents

Chapter 1 GENERAL INFORMATION

1.1 Introduction 3
1.2 Data summary 4
1.3 Accessories 4

Chapter 2 OPERATION

2.1 Input and output connections 6
2.2 Applying an input signal 6
2.3 Attenuation 7
2.4 Avoidance of spurious signals 8
2.5 Fitting in rack mounting case 9

Chapter 3 TECHNICAL DESCRIPTION

3.1 Introduction 10

Chapter 4 MAINTENANCE

4.1 General 11
4.2 Case removal 11
4.3 Lubrication 11
4.4 Resistor check 11

Chapter 5 REPLACEABLE PARTS

5.1 Introduction 12

Chapter 6 CIRCUIT DIAGRAMS

Circuit notes 17
Fig. 6.1 Coarse attenuator circuit 17
Fig. 6.2 Fine attenuator circuit 19

Chapter 1

General information

1.1 INTRODUCTION

TF 2163 is a switched attenuator having a range of 142 dB in 1 dB steps with a frequency range from d.c. to 1 GHz. The instrument case conforms to the Marconi Instruments standard modular dimension system, which facilitates stacking assemblies of instruments or grouping for rack mounting.

The unit consists of switched networks in two cascades, giving steps of 20 and 1 dB. The components are well shielded, both from each other and from external fields, and a feature is the low v.s.w.r. of the system which is 1.5:1 at 1 GHz. Input and output impedances are 50 Ω unbalanced.

TF 2163S (CT553) is a Services version of the attenuator. It differs in having a front panel lid equipped to show a coaxial fuse unit, spare fuses and two type N to BNC adapters.

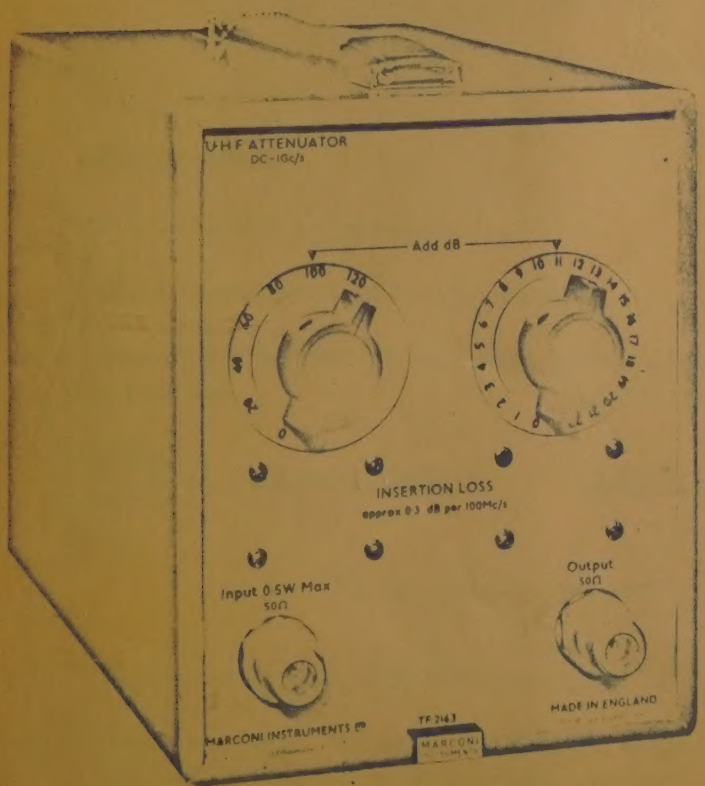


Fig. 1.1 U.H.F. Attenuator

1.2 DATA SUMMARY

Frequency range:	D. C. to 1 GHz.
Attenuation	
Range:	0 to 142 dB in 1 dB steps.
Accuracy at 1 kHz:	0 to 130 dB, ±0.5% ±0.1 dB
Accuracy at 1 GHz:	0 to 100 dB, ±1% ±0.2 dB 100 to 130 dB, ±1.5% ±0.2 dB
Input and Output impedance:	50 Ω.
V. S. W. R. (and reflection coefficient):	Not exceeding 1.1 (26.5 dB) below 200 MHz, 1.25 (19.0 dB) below 500 MHz, 1.5 (14.0 dB) below 1 GHz.
Power input:	0.5 W average.
Insertion loss:	Approximately 0.3 dB per 100 MHz.
Dimensions:	*Height* 7 3/4 in (19.5 cm); *Width* 5 3/4 in (14.5 cm); *Depth* 10½ in (27 cm)
Weight:	8 lb (3.63 kg).

1.3 ACCESSORIES

No accessories are supplied.

The following accessories are available:

a) Lead, TM 4726/286: 18 inch solid outer coaxial cable, with type N plugs at each end.

Fig. 1.2 Solid outer coaxial cable TM 4726/286

b) Rack Mounting Case, TM 7010, for fitting TF 2163 into 19 inch racks.

c) Blank Panel Unit, TM 6844, for filling a space in the rack mounting case. This unit enables you to fit your own circuits in conjunction with TF 2163.

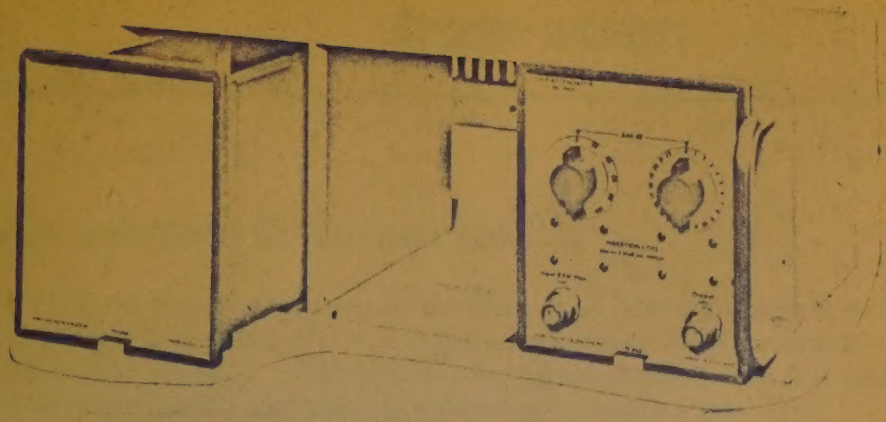


Fig. 1.3 Rack Mounting Case TM 7010 with the left-hand compartment occupied by a Blank Panel Unit TM 6844

d) Coaxial Fuse type TM 5753 (Nato Stock No. 5920-99-932-4381)
This unit prevents damage to the attenuator, through accidental application of r.f. or h.t. power to the circuit under test, and has been designed for use up to 500 MHz. It is normally provided for Services use as a first fitting item for the TF 2163S.

Details:

Overload protection:	Burns out at 0.4 W.
Insertion loss:	Approximately 0.5 dB at 500 MHz.
V.S.W.R.:	To 500 MHz; 1.35 or less when terminated in a matched 50 Ω load.
Connectors:	Type N plug to type N socket.
Fuse:	1/16 A, Littelfuse cat. no. 361.062. (10 spares are supplied.)
Dimensions:	Length 4 7/8 in Diameter 13/16 in

Fig. 1.4 Coaxial Fuse TM 5753

Chapter 2

Operation

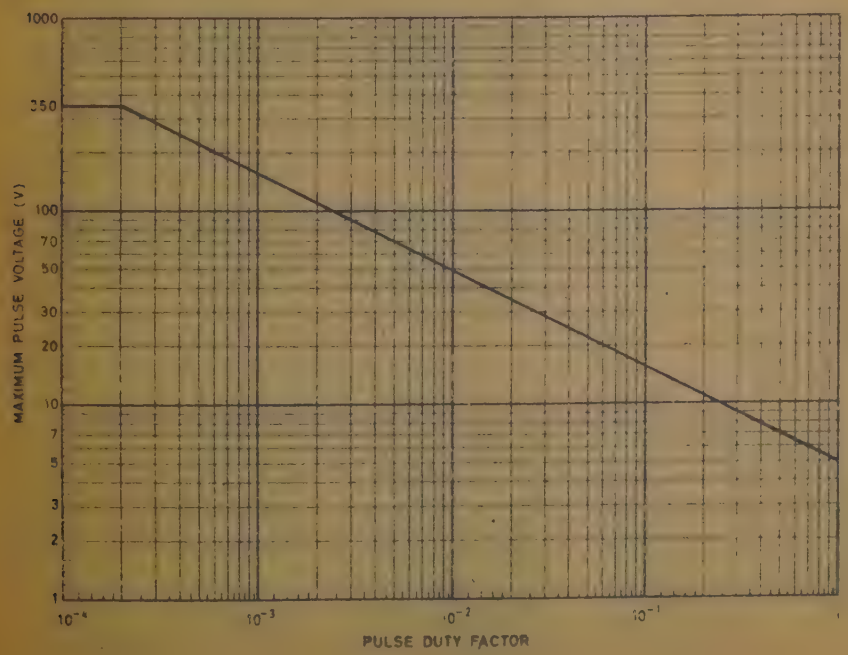
2.1 INPUT AND OUTPUT CONNECTORS

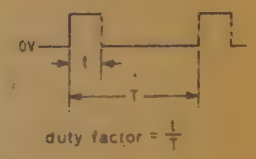
The inlet and outlet connectors on the front panel consist of type N sockets. To preserve the best possible v. s. w. r. the connections to these sockets should be direct through type N plugs. Adapters to other types of connectors will cause some falling off in performance, particularly at the higher frequencies.

To minimize radiation the type N connectors should be tightened. Elsewhere in the circuit radiation may be caused if non-screw connectors are used or if screw connectors are inadequately secured.

2.2 APPLYING AN INPUT SIGNAL

Protect a sensitive load against damage by initially turning the attenuation controls to their maximum before applying a signal through the attenuator. The continuous power rating of the attenuator is 0.5 W, which means that a sine wave input must not exceed 5 V r.m.s. Pulsed inputs must not exceed 5 V peak if the repetition rate is less than 100 Hz; for higher repetition rates the permissible peak voltage increases as the duty factor decreases - see Fig. 2.1 - up to a maximum of 350 V.





Peak pulse voltage plotted against pulse duty factor

Maximum averaging time (T) of 10 msec

Fig. 2.1 Input limits under pulse conditions

2.3 ATTENUATION

At low frequencies, the attenuation is given by the sum of the two dial readings. At higher frequencies the attenuation is given by the sum of the two dial readings, plus the insertion loss of approximately 0.35 dB per 100 MHz as shown in Table 2.1. The value of attenuation is the extent to which the power, or voltage, reaching the load is attenuated relative to that fed into the input, provided the source and load impedance are 50 Ω.

TABLE 2.1

Insertion loss characteristic

Frequency (MHz)	Approx. insertion loss (dB)
50	0.17
100	0.35
200	0.70
300	1.05
400	1.40
500	1.75
600	2.10
700	2.45
800	2.80
900	3.15
1000	3.50

Changes of attenuation are given accurately by the changes in the dial settings. The effect of the constant insertion loss is eliminated by the subtraction of the two settings. To obtain the best possible input v. s. w. r. the coarse attenuator should have at least 20 dB in circuit. If a particularly low output v. s. w. r. is required the instrument should be operated in reverse, with the input and output interchanged, with at least 20 dB in circuit on the coarse attenuator.

When both dials are switched to 0 dB all pads are bypassed and so at lower frequencies the attenuation is zero. At higher frequencies the insertion loss must be considered, see Table 2.1.

For a low insertion loss the coarse and fine attenuator can be disconnected from each other and used singly. To do this remove the instrument case (see Sect. 4.2) and the solid outer coaxial link between the coarse and fine attenuators. For each unit the insertion loss is approximately halved.

With the attenuator dials set to 0 dB a signal passing through the attenuator is delayed by about 6 nsec. This delay is determined by 0.1 nsec approximately per pad in circuit. The number of pads in circuit can be determined from the chart on the circuit diagram.

2.4 AVOIDANCE OF SPURIOUS SIGNALS

Consider a system containing a signal generator feeding the attenuator which, in turn, is connected to a detector (typically a receiver), as shown in Fig. 2.2

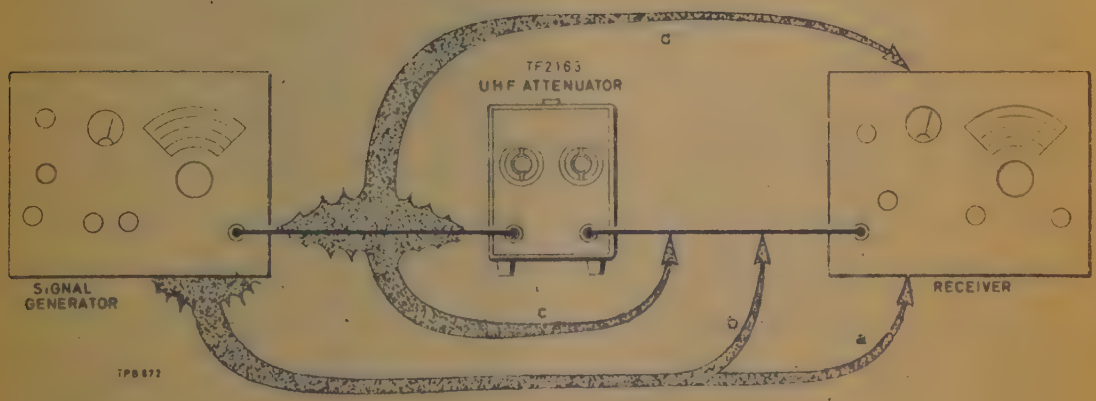


Fig. 2.2 Possible leakage paths

If the parts of the system are not perfectly shielded, stray radiation can be great enough to cause errors in measurement. This is particularly so at high frequencies and when the direct signal propagated through the system is at a very low level, i.e., when high degrees of attenuation are being used. The leakage paths are shown in Fig. 2.2. To avoid direct pick-up, path a, the distance separating the signal generator and the detector should be as large as possible. Paths b, c and d can be avoided by using well shielded leads such as TM 4726/286 which have a solid outer conductor, and by ensuring that all connections are tight. The extent to which these precautions are necessary will naturally depend on how well the signal generator and receivers are shielded but, in general, at frequencies greater than 10 MHz and attenuations greater than 80 dB care must be taken.

2.5 FITTING IN RACK MOUNTING CASE

To fit the attenuator in a Rack Mounting Case type TM 7010, proceed as follows:-

1) Remove the instrument from its case as detailed in Sect. 4.2.

2) Fit the rear cover of the instrument rack mounting case into the slots provided at the back of the case. The large aperture should be lower than the ventilated grating. (The bottom of the case is the separate panel assembled to the remainder.)

3) Select the compartment to be occupied by the instrument, (removable sections divide the case into three sections), and slide the instrument in backwards.

4) Insert the two coin operated screws, which were originally in the case of the attenuator, through the appropriate holes in the rear cover of the rack mounting case and tighten them in the bar at the rear of the attenuator.

Chapter 3

Technical description

3.1 INTRODUCTION

The attenuation circuit provides a range of 142 dB in two stages; 120 dB is provided in steps of 20 dB, and 22 dB in steps of 1 dB, thus 2 dB of overlap is available.

Two sets of resistive π pads form the basis of this attenuator. The coarse attenuator has five pads, three of 20 dB and two of 30 dB: the latter are always switched as a pair. The fine attenuator has pads of 1, 2, 3, 6 and 10 dB.

Electrical shielding is provided in each attenuator unit by a metal casting which houses the pads. The dimensions of the casting, together with the pads, bypass links and microswitches have been designed to maintain the characteristic impedance. Provisions are made, by controlling the spacing of the components and adjustment of the stray reactance, to ensure the maintenance of performance up to the highest frequencies. Long term reliability of the instrument is secured by fitting the microswitches with gold contacts. The resistors used are metal film for stability and axially cut for good frequency response.

The required pads are selected by cams, which operate two microswitches associated with each pad, and so insert or bypass the section concerned. The overloading effects on following equipment that might occur when changing from one attenuator position to another are avoided by inserting any new pads before the unwanted pads are removed.

Chapter 4

Maintenance

4.1 GENERAL

The construction and calibration of this instrument require specialized test methods and jigs; you should not attempt to adjust the h. f. attenuation presets. For adjustment and recalibration the instrument should be returned to our Service Division or local Agents. Our address and telephone numbers will be found at the rear of this manual; in communications with us always mention the type and serial numbers of your instrument.

4.2 CASE REMOVAL

To remove the case of the attenuator:

1) Withdraw the coin slotted screws from the rear of the instrument, and remove the rear cover.

2) Slide the instrument forward from its case. Alternatively, rest the instrument front panel face downwards on a soft surface, and lift the cover off.

4.3 LUBRICATION

The cams and gears are lubricated during manufacture and will require no further lubrication.

4.4 RESISTOR CHECK

If the attenuator has been overloaded, it is possible to check for damage as follows:

Terminate one of the front panel sockets in 50 Ω ±1%. A bridge, such as Marconi Instruments TF 2700, capable of measuring to within 2% should be connected across the other front panel socket. The resistance measured should be 50 Ω ±2% for all settings of the attenuator. The coarse and fine attenuators should be checked independently to ensure that no errors are swamped. If a reading is outside this range a fault exists on the instrument and it should be returned to Marconi Instruments, see Sect. 4.1.

Chapter 5

Replaceable parts

5.1 INTRODUCTION

The parts list contains electrical and mechanical components with miscellaneous parts at the end of the list.

As the calibration techniques are complex the electrical parts are listed for information only; we do not supply the resistors as separate items.

COARSE ATTENUATOR TM 8070

	20 dB	TM 7492/13
	30 dB	TM 7492/14
	30 dB	TM 7492/14

Circuit reference	Description
R1	Met film 53.3Ω ±0.5% ¼ W
R2	Met film 790Ω ±0.5% ¼ W
R3	Met film 53.3Ω ±0.5% ¼ W
R4	Met film 53.3Ω ±0.5 % ±¼ W
R5	Met film 790Ω ±0.5% ¼ W
R6	Met film 53.3Ω ±0.5% ¼ W
R7	Met film 61Ω ±0.5% ¼ W
R8	Met film 247Ω ±0.5% ¼ W
R9	Met film 61Ω ±0.5% ¼ W
R10	Met film 61Ω ±0.5% ¼ W
R11	Met film 247Ω ±0.5% ¼ W
R12	Met film 61Ω ±0.5% ¼ W
R13	Met film 61Ω ±0.5% ¼ W
R14	Met film 247Ω ±0.5% ¼ W
R15	Met film 61Ω ±0.5% ¼ W

Circuit reference	Description	M.I. code
SA	Micro switch	23483-131
SB	Micro switch	23483-131
SC	Micro switch	23483-131
SD	Micro switch	23483-131
SE	Micro switch	23483-131
SF	Micro switch	23483-131
SG	Micro switch	23483-131
SH	Micro switch	23483-131
SJ	Micro switch	23483-131
SK	Micro switch	23483-131
	Spindle	33564-136

The cam closest to the input of this unit is at the top of the list.

Cams	20 dB	TM 7492/11
	20 dB	TM 7492/12

SKT1	Type 'N'	23443-738
SKT2	Type 'N'	23443-738

Circuit reference	Description
R1	Met film 150Ω ±1% ¼ W
R2	Met film 37.3Ω ±1% ¼ W
R3	Met film 150Ω ±1% ¼ W
R4	Met film 292Ω ±1% ¼ W
R5	Met film 17.6Ω ±1% ¼ W
R6	Met film 292Ω ±1% ¼ W
R7	Met film 870Ω ±1% ¼ W
R8	Met film 5.77Ω ±0.05% ¼ W
R9	Met film 870Ω ±1% ¼ W
R10	Met film 436Ω ±1% ¼ W
R11	Met film 11.6Ω ±1% ¼ W
R12	Met film 436Ω ±1% ¼ W
R13	Met film 96.3Ω ±1% ¼ W
R14	Met film 71.2Ω ±1% ¼ W
R15	Met film 96.3Ω ±1% ¼ W

The cam closest to the input of this unit is at the top of the list.

Cam	6 dB	TM 7492/6
	3 dB	TM 7492/7
	1 dB	TM 7492/8
	2 dB	TM 7492/9
	10 dB	TM 7492/10

Circuit reference	Description	M.I. code
SA	Micro switch	23483-131
SB	Micro switch	23483-131
SC	Micro switch	23483-131
SD	Micro switch	23483-131
SE	Micro switch	23483-131
SF	Micro switch	23483-131
SG	Micro switch	23483-131
SH	Micro switch	23483-131
SJ	Micro switch	23483-131
SK	Micro switch	23483-131
	Spindle	33564-136
SKT1	Type 'N'	23443-738
SKT2	Type 'N'	23443-738
	Gear wheel	31313-220
	1 dB step attenuator knob and skirt	41145-230
	20 dB step attenuator knob and skirt	41145-229
	Link (between attenuator units) solid outer coaxial cable	23443-787

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	0	1·0	1·0
·9886	·9772	·1	1·012	1·023
·9772	·9550	·2	1·023	1·047
·9661	·9333	·3	1·035	1·072
·9550	·9120	·4	1·047	1·096
·9441	·8913	·5	1·059	1·122
·9333	·8710	·6	1·072	1·148
·9226	·8511	·7	1·084	1·175
·9120	·8318	·8	1·096	1·202
·9016	·8128	·9	1·109	1·230
·8913	·7943	1·0	1·122	1·259
·8710	·7586	1·2	1·148	1·318
·8511	·7244	1·4	1·175	1·380
·8318	·6918	1·6	1·202	1·445
·8128	·6607	1·8	1·230	1·514
·7943	·6310	2·0	1·259	1·585
·7762	·6026	2·2	1·288	1·660
·7586	·5754	2·4	1·318	1·738
·7413	·5495	2·6	1·349	1·820
·7244	·5248	2·8	1·380	1·905
·7079	·5012	3·0	1·413	1·995
·6683	·4467	3·5	1·496	2·239
·6310	·3981	4·0	1·585	2·512
·5957	·3548	4·5	1·679	2·818
·5623	·3162	5·0	1·778	3·162
·5309	·2818	5·5	1·884	3·548
·5012	·2512	6	1·995	3·981
·4467	·1995	7	2·239	5·012
·3981	·1585	8	2·512	6·310
·3548	·1259	9	2·818	7·943
·3162	·1000	10	3·162	10·000
·2818	·07943	11	3·548	12·59
·2512	·06310	12	3·981	15·85
·2239	·05012	13	4·467	19·95
·1995	·03981	14	5·012	25·12
·1778	·03162	15	5·623	31·62

DECIBEL CONVERSION TABLE (continued)

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
·1585	·02512	16	6·310	39·81
·1413	·01995	17	7·079	50·12
·1259	·01585	18	7·943	63·10
·1122	·01259	19	8·913	79·43
·1000	·01000	20	10·000	100·00
07943	$6{\cdot}310 \times 10^{-3}$	22	12·59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	24	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	26	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	28	25·12	631·0
·03162	$1{\cdot}000 \times 10^{-3}$	30	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	32	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	34	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	36	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1{\cdot}585 \times 10^{-4}$	38	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	40	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	42	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3{\cdot}981 \times 10^{-5}$	44	158·5	$2{\cdot}512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	46	199·5	$3{\cdot}981 \times 10^{4}$
$3{\cdot}981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	48	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	50	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	52	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	54	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	56	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	58	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	60	1,000	$1{\cdot}000 \times 10^{6}$
$5{\cdot}623 \times 10^{-4}$	$3{\cdot}162 \times 10^{-7}$	65	$1{\cdot}778 \times 10^{3}$	$3{\cdot}162 \times 10^{6}$
$3{\cdot}162 \times 10^{-4}$	$1{\cdot}000 \times 10^{-7}$	70	$3{\cdot}162 \times 10^{3}$	$1{\cdot}000 \times 10^{7}$
$1{\cdot}778 \times 10^{-4}$	$3{\cdot}162 \times 10^{-8}$	75	$5{\cdot}623 \times 10^{3}$	$3{\cdot}162 \times 10^{7}$
$1{\cdot}000 \times 10^{-4}$	$1{\cdot}000 \times 10^{-8}$	80	$1{\cdot}000 \times 10^{4}$	$1{\cdot}000 \times 10^{8}$
$5{\cdot}623 \times 10^{-5}$	$3{\cdot}162 \times 10^{-9}$	85	$1{\cdot}778 \times 10^{4}$	$3{\cdot}162 \times 10^{8}$
$3{\cdot}162 \times 10^{-5}$	$1{\cdot}000 \times 10^{-9}$	90	$3{\cdot}162 \times 10^{4}$	$1{\cdot}000 \times 10^{9}$
$1{\cdot}000 \times 10^{-5}$	$1{\cdot}000 \times 10^{-10}$	100	$1{\cdot}000 \times 10^{5}$	$1{\cdot}000 \times 10^{10}$
$3{\cdot}162 \times 10^{-6}$	$1{\cdot}000 \times 10^{-11}$	110	$3{\cdot}162 \times 10^{5}$	$1{\cdot}000 \times 10^{11}$
$1{\cdot}000 \times 10^{-6}$	$1{\cdot}000 \times 10^{-12}$	120	$1{\cdot}000 \times 10^{6}$	$1{\cdot}000 \times 10^{12}$
$3{\cdot}162 \times 10^{-7}$	$1{\cdot}000 \times 10^{-13}$	130	$3{\cdot}162 \times 10^{6}$	$1{\cdot}000 \times 10^{13}$
$1{\cdot}000 \times 10^{-7}$	$1{\cdot}000 \times 10^{-14}$	140	$1{\cdot}000 \times 10^{7}$	$1{\cdot}000 \times 10^{14}$

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors: No suffix = ohms.

2. SYMBOLS

FUNCTION etc., external front or rear panel marking.

Arrow indicates clockwise rotation of knob.

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